

## **INTERIM PROGRESS REPORT**

*Submitted to the*

NOAA Human Dimensions of Global Change Research (HDGCR) Program

June 5, 2006

**Project Title:** “Use of Climate-Information Products by Water Managers and Other Stakeholders in Two GCIP/GAPP Watersheds in Arizona/Sonora and Oklahoma”

*[Note that Oklahoma portion of this grant was awarded under a separate contract to USDA/ARS; the foregoing report pertains only to work undertaken by the University of Arizona team.]*

**NOAA grant number:** NAO30AR4310149

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## **I. Preliminary Materials** *[Note that Section I refers to and is drawn from the original proposal.]*

### **A. Project abstract**

Building upon previous research and outreach efforts in the San Pedro basin (Arizona/Sonora) and Washita/Red-Arkansas basin (Oklahoma), we proposed a three-year project to continue and expand our efforts to 1) assess climate information products/tools for water management, 2) find ways to narrow the communication gap between climate experts and information users, and 3) improve ways to integrate the science of climate with public policy. The San Pedro basin has been designated, with the support of the GEWEX Water Resource Applications Project (WRAP), as a Demonstration Basin (the most advanced, and accordingly, most in tune with the principles and aims of HELP, of four categories) by the UNESCO-based, global HELP (Hydrology for the Environment, Life and Policy) Initiative. The proposed work is intended to expand the body of research related to the theoretical and practical aspects of the role of climate information for water management, stakeholder decisionmaking, and public policy, and build upon the contributions from regional climate impacts and vulnerability assessments, particularly those focused on water basins.

### **B. Objective of research project**

#### **Assess products and tools**

- \$ Assess status of available climate information useful in a transboundary (U.S.-Mexico) context
- \$ Obtain evaluation of transboundary climate information from stakeholders
- \$ Determine product usability, accuracy, and utility in interaction with natural-resource/water stakeholders/managers
- \$ Identify potential opportunities to transfer NAME products into transboundary settings

#### **Bridge communications gap**

- \$ Narrow knowledge and communications gaps between climate researchers/products and area stakeholders
- \$ Identify areas where improvements in climate products could be made and provide feedback to climate scientists/forecasters

#### **Integrate science and policy**

- \$ Assess the potential impacts of climate variability and change on water policy, economic development, and land management/land use practices
- \$ Identify promising avenues for introducing science into policymaking
- \$ Identify innovative ways to link stakeholders with forecasters and forecast models for the interface between land use, climate and hydrology
- \$ Assess the potentials and constraints of using the watershed-council framework and water focus groups for integrating science and policy

### **C. Approach**

#### **Assess products and tools**

- \$ Using archival information and surveys, analyze trends in demographics, institutional changes, water management, economic growth, and land use/land tenure arrangements.
- \$ Using focus group and workshop techniques, assess need for/use of climate information.
- \$ Introduce stakeholders to climate forecasts and related information through structured workshop settings; use structured workshop interactions, as well as follow-up surveys, as needed, to obtain feedback on utility, usability, and perceived accuracy of the information provided.

- \$ Conduct structured analysis of results of focus groups, workshops, and surveys to assess climate perceptions and how these are linked with decisions/actions.
- \$ Using the DSS model developed by Dr. Kevin Lansey, assess the sensitivity of water resources on Mexican side of border to climate variability (assuming sufficient data are available to conduct the analysis) and evaluate impacts of climate change projections on the hydrology of the San Pedro basin (AZ) using emission scenarios. Drawing on the results of surveys and focus groups, assess the capacity of basin residents to design and implement adaptive management strategies that reduce/avert vulnerability to climatic stresses.

#### Bridge communications gap

- \$ Conduct preliminary focus groups to ascertain how participants define and view climate, identify the types of climate conditions that pose the greatest concern, as well as the greatest potential benefit to area residents and to identify current coping mechanisms.
- \$ Hold capacity-building workshops in the use and interpretation of climate information with watershed councils or climate and resource focus groups.
- \$ Establish a regional coordinator/facilitator in southwestern Oklahoma to promote the collaboration of federal and state water agencies, tribes and local landowners on regional water, climate, and land-use issues.

#### Integrate science and policy

- \$ Investigate land tenure, soil and water management in Mexican portion of the San Pedro for policy implications under conditions of climate variability and change.
- \$ Carry out a structured assessment of the results of the research conducted in this project to determine extent to which science is already integrated into policy structures and the potential for/barriers to introduction of climate information into such processes.
- \$ Identify changes that must be made in organizational, institutional, and professional frameworks in order to increase the integration of science into policy making and implementation processes, including enhanced participation of community members in scientific research as well as increased outreach from scientists to residents of the region.
- \$ Include range of results in DSS model to support water management in the basin.

## **II. Deviations from Proposal** *[Note that the first part of this section is repeated from last year's (2004-05) report and should be understood as background material for the discussion that follows in the part indicated below.]*

Rather than include this discussion within the Accomplishments section below—which would tend to obscure the modifications to the workplan—we are presenting this before the report on work done.

In the first annual progress report (June 2004), we highlighted the difficulty of assessing information on climate variability in real time. We also noted the cross-border disparity in availability of information and expertise. And, we indicated implicitly that on both sides of the border, for different reasons, attention to climate-related issues does not enjoy widespread priority among either decisionmakers or other stakeholders. These challenges persist and will not soon dissipate.

During the 2004-5 year, the project team experienced a set of previously unfelt constraints. Beginning just before the end of the first project reporting period, a significant set of political developments occurred in the Mexican portion of the San Pedro basin. Notwithstanding the research team's longstanding and well-received presence, experience, collaborative relationships, and record of accomplishment in Sonora, larger forces came into play.

The project's aim to foster greater understanding and acceptance of integrating climate forecasting with water management, and to do this via community-based water councils was met with varying degrees of wariness. At the most local level, our efforts were supported by several community groups such as a then-incipient environmental NGO (nongovernmental organization), ARASA (Sonora-Arizona Regional Environmental Association) and by officials of the municipalities of Cananea and Naco. But historic differences of opinion surfaced between on the one hand, the strong Cananea-based mining interests and their state government supporters, and on the other hand environmental groups such as ARASA. Compounding this dynamic, regional officials of the Mexican national water commission (CNA) expressed concern that only officially-designated watershed councils were authorized to operate in the area (none has yet been so designated for the San Pedro). Additionally, the highly centralized CNA defines its priorities nationally, leaving small, lightly-populated basins such as the San Pedro poorly funded and without influential champions. Even at the regional level, the CNA in Sonora simply does not consider the San Pedro among its highest priorities, given its range of more pressing needs and demands from larger urban and major agricultural areas. Adding to the uncertainty, after more than a decade of increasing closeness between Mexico and the United States, the events of 9/11 and its aftermath have resulted in distinctly cooler relations—a state of affairs that has palpably affected transborder cooperation. And finally, the situation is further complicated by the fact that a very significant presidential election is coming up in mid-2006. It is not clear what the new leadership will be, and how much of the Fox/Zedillo reforms will be carried through by the new administration—in particular, in regard to water councils and formalized public participation.

In such a context, those aspects of the project that could be seen as going beyond mere research (as expressed in the opening sentence of the preceding paragraph) were interpreted by some as uninvited involvement in the affairs of another nation. The manifestations of this new attitude were mostly subtle and certainly not overtly hostile, but it became clear that our investigators could not easily attend official meetings, interview key personnel, or gain access to such relevant information as exists. This situation may have eased somewhat in recent months and we have perceived a shift toward more openness on the part of CNA and others to our research entrees. This leads us to believe that things are moving in a positive direction. Nevertheless, given the lifetime of the grant, we may not be able to capitalize on these improvements to the extent we would have a year earlier.

Meanwhile, in Arizona, on the U.S. side of the border, much of the responsibility for managing the San Pedro basin has accrued to the Upper San Pedro Partnership (USPP). The USPP, over the past six or seven years has become the dominant force in the U.S. portion of the upper part of the watershed. With strong congressional and state support, this alliance of more than 20 agencies and NGOs has grown and gained respect. In the past year, the USPP was charged by the U.S. Congress with responsibility for assuring the sustainability of water in the basin.

Over the years, the Udall Center has been instrumental in the formation and maturation of the USPP and one of the project co-PIs, David Goodrich, is an influential member of the Partnership. In addition, we have co-authored numerous scientific and policy-oriented papers with members of the USPP. As a result, the research team has maintained excellent relations with the USPP and its leadership. The USPP has been highly receptive to attempts by the project, especially during the first year, to build binational, cross-border institutional relationships (as noted in the first interim report). But because of the past year's developments, we have decided to postpone further promotion of such linkages, which could be seen as unnecessarily intrusive. The chief constraint we have felt has been the relatively cautious approach taken by the USPP in regard to use and integration of climate forecasting tools in its water management planning activities.

Accordingly, in September 2004 the project team met and decided to redirect some of its activities—in particular, those tasks that could not be undertaken in the present climate (and we note here that we had already accomplished a great deal of fieldwork prior to the shift in relations, so that overall the impact of the political shift was muted somewhat). As a basis for the revision, the PI and co-PIs agreed, insofar as possible, to retain the overarching objectives of the project, namely to, (1) assess products and tools, (2) attempt to bridge the communications gap, and (3) work to integrate science and policy.

In 2004 the research team leadership resolved to reconfigure the project's activities as follows:

- \$ Continue to convene, attend, and participate in relevant meetings on both sides of the border, while solidifying relationships with policymakers, managers, and other stakeholders.

- \$ Identify appropriate, distinct, achievable research papers to be jointly-authored and submitted to peer-reviewed journals.

- \$ Highlight the scientific aspects of the project, which seem to be more attractive to Mexican officials and others than the pursuit of policy-related objectives, most specifically by developing a prototype "Climate Outlook" package for the U.S.-Mexico border area modeled on CLIMAS's product for the southwestern United States, and by collaborating on the use of decision-support tools.

- \$ Address the communications gap via new curriculum development efforts.

- \$ In all these undertakings, redouble our resolve to work closely with Mexican colleagues, especially in the academic sector, thus alleviating the perception of external interference in Mexican domestic affairs while strengthening our credibility and building strong research alliances.

The team further concluded that the political developments that occasioned the changes, while unanticipated and problematic, also presented a good opportunity to analyze and write about those developments. The situation clearly offers particular insights into politics, water decisionmaking, and agenda-setting in Mexico as well as more general lessons that could be of use elsewhere.

→ *[2006 update begins here.]*

Encouraged by the success of the collaboration with CLIMAS on the Climate Outlook prototype for Mexico, beginning in July 2005, the project team determined to greatly strengthen its connections to other regional NOAA projects and to other cross-border, climate-related efforts. Thus, this project began working much more closely with the Physical Sciences Division (formerly Climate Diagnostics Center) of NOAA's Earth Systems Research Laboratory, the Western Water Assessment RISA, the NCAR Research Applications Laboratory, and the North American Monsoon Experiment (NAME).

At the same time, we came to realize more pointedly than before that to achieve success regionally—in Sonora, where our political problems were most manifest—we needed to link ourselves more strongly to federal agencies, officials, and researchers in the area of Mexico's capital. Over the past 11 months, we have therefore greatly enhanced our collaborations with Mexico's National Meteorological Service (SMN); National Water Commission (CNA); the two binational transboundary water commissions, the Comisión Internacional de Límites y Agua (CILA) and its U.S. counterpart, the International Boundary and Water Commission (IBWC); and key research institutions such as the National Institute for Water Research (IMTA); the National Autonomous University (UNAM); and other academic centers such as CISESE and COLEF in Baja California, ITSON, COLSON, and UNISON in Sonora. Through a series of meetings and workshops and a conference, we are now much better integrated into the larger climate-research/climate-product-delivery network.

In Sonora itself, contact with high level Mexican CNA officials and with representatives of the Sonora State Water Commission confirmed the complex nature of Mexican water-and-climate policy and practice—especially in transboundary settings. According to CNA officials, water is owned by the

Mexican federal government on behalf of the nation and therefore cannot be the subject or state or local transboundary planning. Nonetheless, it should be noted that several forms of collaboration on transboundary watersheds do exist along the U.S.-Mexico border: the Tijuana River Watershed, the Mimbres basin, and, to a lesser degree, the RPo Bravo-Rio Grande River basin (New Mexico Water Resources Institute and Centro de Información Geográfica for the Paseo del Norte). In addition, the CILA actively encourages transboundary watershed collaboration, including the binational support and use for 12 computer planning models (presentation, Arturo Herrera Solis, Mexican CILA commissioner, May 22-24, 2006). Still, intergovernmental uncertainty about the process of decentralizing Mexican watershed management and climate-information management makes it a challenge to work in this one sector in a truly transboundary manner.

Meanwhile, on the U.S. side of the border in Arizona, much of the responsibility for managing the San Pedro basin has accrued to an independent nongovernmental watershed initiative, the Upper San Pedro Partnership (USPP). Over the past six or seven years the USPP has become the dominant force in the U.S. portion of the upper part of the watershed. With strong congressional and state support, this alliance of more than 20 agencies and NGOs has grown and gained respect. In spring 2006, the USPP drafted a Long-Range Planning Document for 2006–2011, reinforcing their effort to “apply the best available science and engineering both to defining the challenges and in evaluating solutions.” One of these tools is a Decision Support System (DSS) model, developed partly by project researchers Aleix Serrat Capdevila and Anne Browning-Aiken, working with Drs. Kevin Lansey, Juan Valdes, and other colleagues elsewhere at the University of Arizona. Thanks to the present project, this DSS model contains—for the first time—*climate* as well as water-management components, which the USPP now employs to establish alternative management scenarios.

In addition, on the Mexican side of the border, both the Colegio de Sonora (COLSON) and the University of Sonora (UNISON) have expressed interest in adapting this DSS model for application in northern Sonora. Through various presentations, seminars, workshops, and other programs, researchers at the Udall Center and SAHRA have introduced Mexican students and water managers to the model and given them the opportunity to test it by exploring alternative management strategies.

### **III. Accomplishments (Research Tasks, Preliminary Findings, Papers/Presentations)**

This section is organized to reflect the revised structure as outlined in the preceding paragraph.

#### **A. Research Tasks**

##### **1. Bridge communications gap and integrate science and policy: Solidifying relationships with policymakers, managers, and other stakeholders**

During the reporting period, as shown in the list of meetings presented below, the project team interacted with numerous decisionmakers and scientists working in the binational San Pedro River basin in order to (1) better understand the current role of climate in decisionmaking about water in the Arizona-Sonora region; (2) determine the impacts of recent Mexican policy changes regarding water and the environment on basin water management; (3) promote the use of a Decision-Support System model with climate components by watershed decision-makers, educators, and graduate students; (4) introduce bilingual climate variability and drought units into primary and secondary schools within the basin; and (5) explore the possibility of establishing and promote the use of a binational climate-diagnostic product for northern Mexico to support exchange of data and technology and to improve use of climate information in water planning and management.

Those consulted include elected officials such as the mayor of Sierra Vista, and Cochise County supervisors in Arizona; agency directors and planners such as COAPAES state water managers and officials of the Mexican national water commission; and leaders of Arizona watershed organizations and state agencies. Additionally, team members met with colleagues interested in climate and water management from the University of Arizona, the University of Sonora, El Colegio de Sonora, and Mexican meteorologists at the national level. The PIs attended watershed council meetings, binational climate and water seminars, and organized climate workshops with stakeholders. Key interactions included:

\$ August 2005. Participated in Arizona Virtual Water University (now called Arizona Water Institute), Arizona Water Summit and 2005 Southwest Sustainability Expo

\$ September 2005. Participated in Drought Planning for Small Water Providers and Communities, Arizona Hydrologic Society, in cooperation with SAHRA, CLIMAS, and Cooperative Extension, sponsored a drought and water supply planning workshop Flagstaff. The Udall Center helped plan for a workshop focused on using drought history and forecasting in drought planning, including information on atmospheric patterns related to drought, and potential effects of climate change. The workshop concluded with a session on integrating drought planning with water supply planning. Instructors: Gregg Garfin (CLIMAS), Michael Crimmins (Extension), Kathy Jacobs (SAHRA/Water Resources Research Center/Extension).

\$ ———. Participated in workshop of Sustainability Under Uncertainty in Arid and Semiarid Ecosystems (SUUASE) project, funded by NSF.<sup>1</sup>

\$ ———. Attended meeting of Upper San Pedro Partnership, Technical Advisory Committee, on using the DSS model with climate components.

\$ July 2005-June 2006. Participated in monthly teleconferences with Hydrology for the Environment, Life and Policy (HELP) partners from other North American basins regarding exchange of watershed-management strategies.

\$ January 2006. Held NOAA research team planning meeting.

\$ ———. Convened workshop in Hermosillo, Sonora, to discuss implementation of binational Climate Outlook diagnostic product for border region and to plan for May 2006 conference on NAME

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<sup>1</sup> NSF Grant No. SES-0345944, “Management of Ecosystems in the US Southwest and Related Areas of Northern Mexico in the Context of Complex Uncertainties.” This is an ISPE (UA Institute for the Study of Planet Earth) project funded under NSF's Decision Making Under Uncertainty initiative; one of the co-investigators on this NOAA grant, Barbara Morehouse, is the PI on the NSF grant, and the PI for this NOAA grant, Robert Varady, is one of the four co-investigators of the continuing SUUASE effort. The funding supported two workshops and several associated activities aimed at determining the potential for developing two binational research, education, and outreach centers, one at the University of Arizona and the other in Hermosillo (CIAD), that would focus on sustainability along the US-Mexico border in the context of complex biophysical and societal uncertainties (such as the political constraints described in the preceding section). The primary research focus is the greater Sonoran Ecoregion, which includes riparian areas such as the San Pedro River Basin. While this project is independent of the one on which we are reporting, the two are closely connected insofar as they address the same geographic area and share many of the same objectives. To some extent, the SUUASE proposal reflects insights accumulated from ISPE's CLIMAS experience and from the present NOAA project.

applications. Met at University of Sonora with representatives of SMN, IMTA, CNA, Protección Civil (Sonora), NCAR, CLIMAS, and NOAA. Workshop was financed by supplementary funds from NOAA..

\$ March 2006. Participated in NOAA Climate Prediction Applications Science Workshop: Research and Applications on Use and Impacts, National Weather Service Climate Services Division, in conjunction with the University of Arizona Climate Assessment for the Southwest; Arizona Cooperative Extension is hosting the Fourth Climate Prediction Applications Science Workshop (CPASW) in Tucson, Arizona. The workshop brought together a diverse group of climate-science producers and users to share and discuss developments in research and applications related to the use and impacts of climate predictions on societal decision-making and resource management. The meeting goals were to identify new climate-prediction applications research, promote interactions between climate-sensitive integrated research and service communities, and assess impacts of climate forecasts on environmental-societal interactions.

\$ ———. Participated in Fourth World Water Forum, Mexico City. Made formal presentations (see listing at end of report) and convened meeting of Climate Outlook product partners (leading Mexican climatologists, including several who attended January 2006 workshop in Hermosillo) to discuss potential collaboration on northern Sonora climate diagnostic project.

\$ ———. Convened ECOSTART workshop on water and climate in Cananea, Sonora, with local teachers, under auspices of International Rotary Club.

\$ May 2006. Helped organize and participated in Monsoon Region Climate Applications: a Binational Workshop, hosted by the Instituto Tecnológico de Sonora (ITSON), Guaymas, Sonora, Mexico. This binational workshop on Monsoon Region Climate Applications continued the progress of several NOAA-funded efforts in the monsoon region. The goals of the workshop included:

- Development of links between the monsoon and climate science efforts in the region;
- Development of links between social-science and applications efforts in the region seeking to understand user sensitivity and needs for forecasts and to engage in activities to narrow the communication gap between climate experts and information users;
- Finding ways to integrate climate science with planning and policy activities in the region, in particular, water management, drought management, ecosystem resources, and public health;
- Planning activities to develop and make climate information available across the region—for example, the Climate Outlook product, a regional climate center, a regional climate assessment center;
- Promotion of the creation of a regional integrated science and assessment effort;
- Development of ways to provide more and better training opportunities.

\$ May-June 2006. Participated in planning and discussion of transboundary water and climate issues, Arizona-Mexico Commission, Border Issues Committee, Sierra Vista, AZ  
\$

## **2. Jointly-authored, Peer-reviewed Research Papers**

### **a. “Collaborative Knowledge Production for Improved Water Management in the US-Mexico Border Region” – Barbara Morehouse, Robert Varady, and Margaret Wilder**

A precis has been developed for a paper to be published in a peer-reviewed journal. This paper will evaluate efforts to co-produce a shared knowledge base for implementing a binational watershed collaboration in the upper San Pedro River basin. The insights gleaned from the analyses will be useful

for identifying key barriers and opportunities that influence successful co-development of knowledge for border-area decisionmaking. The paper will propose recommendations for how the potential for success of such endeavors might be enhanced. It is anticipated that this paper will be submitted for peer review by late Fall 2006.

**b. “Discourses of Decentralization: Urban Water Management in Northern Mexico” –**  
*Margaret Wilder and Barbara Morehouse*

Based upon research conducted in Sonoran urban areas in 2003-2005, this article will examine 1) the theoretical discourses surrounding the concept of decentralization and the implementation of decentralization strategies in Mexico, Latin America, and other countries; and 2) will subsequently analyze how these discourses are grounded within five specific Sonoran urban sites and experiences. Is decentralization delivering upon its promise in terms, for example, of enhanced democratic process or better incorporation of climate information and science for water planning?

Research Sites: Eight major Sonoran cities located throughout the state are included in the study: Nogales, Cananea, Naco, Hermosillo, Empalme/Guaymas, Obregon, Navojoa, and Alamos.

Methodology: Semi-structured, open-ended interviews have been conducted with approximately 50 stakeholders in the Sonoran study sites. To complete missing data, follow-up interviews have been conducted with some respondents. Fieldwork began in January 2004, was completed in December 2005.

Schedule:

Preliminary report and newsletter update: February 1, 2006

Article draft writing: August 2006

Review and Revision (by co-authors): October 1, 2006

Article submission to refereed journal: November 1, 2006 (estimated date)

**c. “International Water Reforms, Climate Science Use in Sustainability Planning, and the Role of Watershed Councils: The Case of Northern Mexico” –**  
*Margaret Wilder and Nicolás Pineda*

This study is closely-related to the decentralization study, and has essentially the same focus; however, the institutional analysis is focused on watershed councils rather than urban water management, in Sonora. Much of the fieldwork was carried out in tandem with the decentralization study, since many of the stakeholders especially in government positions overlap between the two. NOAA funding available through both the Udall Center and CLIMAS have sustained these two research projects.

There are three principal watershed councils in Sonora: the Upper Northwest (including the Upper San Pedro River); the Rio Yaqui/Matape; and the Rio Mayo. These were formed as a result of the 1992 national water law reforms and additional reforms adopted in April 2004.

As part of a decentralized governance strategy, many countries around the world have turned, under the influence of the World Bank, to a greater focus on regional watershed councils as a principal feature of water management structures. What are the aspirations for these watershed councils, their long-term goals and objectives? Does the watershed council structure provide sufficient human/technical/financial/jurisdictional) capacity for decisionmaking? Is there evidence to suggest that the watershed-council approach results in more sustainable water planning or allocation, or helps in conflict resolution? Are the councils more participatory and democratic, and if so, is it in meaningful ways? Are they able to utilize climate information and climate science to inform water planning decisions?

Reforms to Mexico's National Water Law (LAN) in April 2004 strengthened the existing provisions of the LAN for a regional watershed approach. The state of Sonora in arid northern Mexico has three regional watershed councils: the Rio Yaqui, the Rio Mayo and the Alto Noroeste (Upper Northwest, including the Upper San Pedro and Rio Concepción watersheds: Naco/Cananea/Caborca) councils, as well as a hierarchy of subregional and local watershed councils. Research begun in 2003-04 (Wilder/Sanford) and continued in 2005-2006 (Wilder) focused on how the watershed councils were established, what are their main purposes, how they function, and what gains have they made/obstacles they have faced, to date. In particular, we have focused on three questions: have the watershed councils resulted in increased (and meaningful) public participation (enhanced democratic institutions)?; have they resulted in a more sustainable approach to water management? And have they utilized appropriate climate science and information to improve water planning?

Objectives: Analyze what climate information and science is currently available to watershed councils; analyze how existing climate information is being utilized by watershed councils (Have the watershed councils led to an increased demand for climate science and information, or led to more "sustainable" decisions?); and analyze the institutional features of watershed councils: areas of formal jurisdiction, content of agendas, structure and functioning of watershed councils.

Methodology: Semi-structured, open-ended interviews have been conducted with approximately 50 stakeholders in the Sonoran study sites. To complete missing data, follow-up interviews have been conducted with some respondents. Fieldwork began in January 2004 and is being completed in June 2006.

Wilder has attended three watershed council meetings, and have scheduled attendance at more during the June-August 2005 period. (Note: Until recently, federal water officials in Hermosillo who supervise the watershed council effort have been reluctant to allow outside researchers to attend watershed council meetings; thus, our access has been quite limited. Nevertheless, recently we have begun to be advised of meetings with 1-2 weeks notice so we can attend, and we have been told we are welcome at meetings held over the coming summer months).

Schedule:

Article Draft: August-September 2006

- a. Wilder and Pineda met in February 2006, in San Diego for working meeting
- b. Pineda completes fieldwork in Hermosillo, June 2006
- c. Article draft deadline: September 15, 2006
- d. Review and revision: October 15, 2006
- e. Submit to journal: November 1, 2006

**d. "Challenges to Implementing Transboundary Water Planning: A Political Ecology Perspective on Recent Policy Changes, Management Regimes, and Institutional Practices in U.S. and Mexico" – Nicolás Pineda and Anne Browning-Aiken**

Based partly on Pineda's interviews since 2005 in Cananea and Naco with water managers and officials, this paper will report on research into funding and service issues. The authors employ a neoliberal theory approach (although this is really a critique of local application of neoliberal theory or philosophy) by contrasting policy with on-the-ground management practices and by discussing the challenges and potential political or institutional changes that could help implement climate and water policy regionally

and locally. The paper is in progress and early versions have been presented at conferences and workshops.

### **3. Scientific Cooperation**

#### **a. Development of a prototype “Climate Outlook” package for the US-Mexico border area**

Research team: Robert Varady, Gregg Garfin (CLIMAS), Barbara Morehouse ISPE), Andrea Ray (NOAA), Henry Diaz (NOAA), Miguel Cortez (SMN/Mexico City), Chris Watts (UNISON/Hermosillo), René Lobato (IMTA/Cuernavaca), MartPn Montero (IMTA), Jaime Garatuza (ITSON/Ciudad Obregon, Sonora)

#### Background:

Beginning in mid-2005, the project research team began developing a draft prototype “climate outlook” package for the Mexico border area. This prototype is based on a monthly outlook for Arizona and New Mexico produced by the NOAA/OGP-funded Climate Assessment for the Southwest (CLIMAS) Project (available at [www.ispe.arizona.edu/climas/forecasts/swoutlook.html](http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html)); and an analogous product, the Intermountain West Climate Summary prepared by the Western Water Assessment ([www.colorado.edu/products/forecasts\\_and\\_outlooks/intermountain\\_west\\_climate\\_summary/](http://www.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/)).

The value of a single source for climate information, such as the Southwest Climate Outlook, has been validated through research conducted by CLIMAS and other RISAs. Participants in the extended survey of the Arizona-New Mexico climate outlook package were found to place high value on region-specific commentary included with the climate products, and to prefer “one-stop shopping” for information produced by different agencies. The prototype border-area package (see 2005 annual report for outline and sample contents) brings together in one place information available from a variety of sources in the U.S. and Mexico on drought status, surface water status, recent temperature, and forecasts for the coming month and season (see attached table of contents and graphics). With further development, we anticipate that the package will also include value-added, region-specific information contributed by U.S. and Mexican scientists.

Since August 2005, the research team has attempted to enlist Mexican collaboration by convening four important meetings—all in Mexico.

- The first was in Cuernavaca, at IMTA headquarters, in August 2005, and was attended by Michel Rosengaus, the director of Mexico’s National Meteorological Service (SMN); Javier Aparicio, the director of IMTA’s hydrological applications program and René Lobato, its director of climatological processes, and two of Mexico’s leading climatologists (Carlos Gay and Cecilia Conde).
- A follow-up meeting was convened in Hermosillo, Sonora, in January 2006; it was attended by about 15 persons, including not only researchers from SMN (Miguel Cortez) and IMTA (MartPn Montero), but also key actors in the state of Sonora, such as representatives of CNA (Carlos Arias), the emergency response office (Wilebaldo Alatraste Candiani), UNISON (Chris Watts), and ITSON (Jaime Garatuza). At that meeting, we reviewed the concept of the diagnostic climate outlook product and discussed ways to work toward its joint implementation. Attendees, including representatives from NOAA/Boulder (Andrea Ray) and NCAR (David Gochis) also planned for the much larger May 2006 conference to be held in Guaymas on the subject of applications from the North American Monsoon Experiment. This session was funded separately by NOAA Headquarters.

- A third planning meeting was convened in conjunction with the Fourth World Water Forum, held in Mexico City between March 16 and March 23. Again, important officials of SMN (Valentina Davydova, the deputy director, and Cortez); IMTA (Aparicio, Lobato, and Montero); and three University of Arizona researchers participated. Discussions included ideas for securing funding to begin producing the outlook product. Clearly, by this time, the Mexican officials were keen on the idea and ready to begin a partnership. This meeting, too, was supported by funds from NOAA Headquarters.

- The fourth session was the Guaymas conference, held between May 8 and May 11, 2006 (see also listing on page 8, above). This event was attended by about 60 persons, with more than half from Mexico. All of the individuals named above were there, as well as many other researchers, officials, and stakeholders. The two major additions were Ing. Arturo Herrera, the commissioner of the Mexican CILA (the international border water commission) and his counterpart, Carlos Marin, the acting commissioner of the IBWC, the U.S. section of the commission. Both of the commissioners seemed willing to lend support to the climate outlook idea as well as to a host of other climate/water-related undertakings. The conference, whose Web site is at [www.ispe.arizona.edu/climas/conferences/monsoon2006/](http://www.ispe.arizona.edu/climas/conferences/monsoon2006/), ended with the adoption the following action items:

1. A community of scientists, managers, and policymakers exists with interests in applications of climate research in the monsoon region. These include climate and social scientists, and resource managers and policymakers from local, state, and federal agencies in the U.S. and Mexico.
  - There is an interest in regular meetings such as this every 18 months or 2 years.
  - There is a need for a means for communication among this group, via an email listserv and a Web page.
  - We should sponsor special sessions at appropriate professional society meetings.
2. There is interest in and a need for a bi-national Climate information product in English and Spanish, and an agreement that such a product would help develop scientific literacy about climate information in the region.
3. There is a need for a regional climate center for northwest Mexico and the border region, which would serve as a center for information not only for this region in Mexico, but also to develop “borderless” products for the many users with transborder interests.
  - The SMN supports the idea of a regional climate center, but agreements need to be worked out on authorities.
4. There is a need for “Regional integrated science and assessment” for this region, similar to the model developed in the U.S.
5. Stakeholders for climate information in the monsoon region are diverse. Sectors include:
  - Drought and natural hazards management, including flooding, wildfires
  - Water management at several spatial and management scales, including urban water, irrigation, reservoir management, dryland farming and ranching, and management of water under the IWBC/CILA
  - Management of protected areas and ecological diversity and sustainability
  - Coastal management
  - Public health
  - Fisheries of the Gulf of California
6. There is a need for funding that is stable for activities like a regional climate center, a binational climate information product, and regional assessment. The participants recognize that funding is likely to come from multiple sources.
7. There is a need for training opportunities for people, e.g. for more interdisciplinary understanding, for people who are integrators, and for specific tools for use in resource management, e.g. GIS.

The Guaymas conference was funded by a grant from NOAA Headquarters to the Physical Sciences Division of NOAA’s Earth Systems Research Laboratory in Boulder.

Once the concept and prototype has been fully accepted and endorsed by Mexican scientists, managers, and policymakers for further development, we hope to conduct a user survey of the prototype by distributing copies of the outlook to selected border-area stakeholders for their evaluation and suggestions for revision and improvement. The ultimate goal is for production and dissemination of the outlook to be undertaken and implemented by the appropriate Mexican stakeholder entity.

In spite of the progress made over the past nine months, it is important to note that further work on the border-area outlook is proceeding with extreme caution due to the political issues discussed above and the imperative need to secure approval from Mexican entities such as the CAN and SMN.

**b. Collaboration on the use of decision-support ( DSS) tools: Coupling hydrologic modeling with policymaking to assess the impacts of climate variability and change**

Research team: Kevin Lansey, Aleix Serrat Capdevila, Alice Williams (SAHRA), and Anne Browning-Aiken

Background

As a consequence of a series of meetings with academic colleagues in Sonora, research team members came to appreciate the desire to develop a set of decision-support systems (DSS) tools that would be of mutual benefit. Beginning in the first project year, work was under way on such a tool being developed by UA engineering professor Kevin Lansey, under the auspices of the SAHRA project (see June 2004 and July 2005 progress reports).

Objective

Allocating water resources within a basin is a complex problem. Population growth, industrial development, and agriculture have brought major societies to the edge of water resources availability. Furthermore, human development is affecting global climate patterns (climate change). Assessing the impacts of climate variability and change in water resources and planning for future management strategies requires holistic and interdisciplinary approaches, merging physical sciences and policy making. While climatic and hydrological models serve as physical bases for estimating hydrologic futures, decision support systems provide a common arena for stakeholder involvement and consensual science-based decision and policy making. Also, agent-based models can recreate stakeholders in a basin and assess potential policies by evaluating emergent patterns.

The overall goal of this research is to provide a multidisciplinary approach and a set of tools to enable adaptive capacity in the management of regional watersheds in the face of large variability and potential climate change. For this, it is necessary to bridge physical hydrology knowledge with policy and complex systems theory for the socio-ecological management aspect.

The first objective is to quantify the impact of different climate change scenarios on the water resources of different basins throughout Arizona, namely the San Pedro River, the Salt River, and the Verde River basins. All of these watersheds support important human developments and environmental areas, and are characteristic of different hydrologic regimes within the state. Work is under way in the San Pedro basin, where changes in temperature and precipitation—thus in groundwater recharge—are being evaluated with hydrological models to assess potential changes in the basin's water budget.<sup>2</sup>

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<sup>2</sup> The US Congress mandate in the San Pedro Basin requires safe yield (withdrawals = recharge).

The second objective is to present a representative range of potential climate-change impacts in a manner understandable to stakeholders and decisionmakers. In the case of the transnational San Pedro, the objective is to include these climate-change scenarios and their hydrological impact in the Decision Support System model (DSS) that is being developed for the Upper San Pedro Partnership (USPP).

Assessing the climate variability and change impacts on the water resources of the Verde, the Salt, and the San Pedro—three regional basins with different hydrologic regimes—will provide a powerful insight on climate variability and change effects and the degree of vulnerability of Arizona’s watersheds to such changes. The inclusion of these potential impacts on the hydrology in the San Pedro basin’s DSS model will allow the USP Partnership to evaluate strategies to meet safe yield and cope with a changing water balance under future scenarios. For all three basins, the ability of adequate policies to face global change impacts will help provide sustainable solutions for the short term and build adaptive capacity to accommodate change, should it ever come.

### Progress

An initial binational meeting took place in July 2005; that meeting was attended by José Maria Martínez (Universidad de Sonora), José Luís Moreno (Colegio de Sonora), Nicolás Pineda (Colegio de Sonora), Manuel de Jesús Sortillón (Universidad de Sonora), Pablo Wong (Centro de Investigación en Alimentación y Desarrollo), Anne Browning-Aiken (Udall Center), Aleix Serrat (Udall Center and SAHRA—representing Prof. Lansey). The subject of the session was “Explorando Modelos de Ayuda a la Decisión para la Gestión del Agua en Arizona/Sonora: El ejemplo del Río San Pedro” (“Exploring Decision Support Models for Water Management in Arizona-Sonora: The Example of the San Pedro River”). At El Colegio de Sonora, in Hermosillo (organized by Anne Browning-Aiken and Aleix Serrat Capdevila). The meeting was extremely interactive and positive and evinced serious interest on the part of the Mexican academics. Among future plans is another meeting in the fall to discuss the inclusion of climate components in the proposed DSS model.

Over the past year, on the Mexican side of the border, both the Colegio de Sonora (COLSON) and the University of Sonora (UNISON) have expressed interest in adapting this DSS model—with its new inclusion of climate information—for application in northern Sonora. Through various presentations, seminars, workshops, and other programs, researchers at the Udall Center and SAHRA have introduced Mexican students and water managers to the model and given them the opportunity to test it by exploring alternative management strategies.

### Activities

- July 2005. Organized and participated in a session, at El Colegio de Sonora, Hermosillo: “Explorando Modelos de Ayuda a la Decisión para la Gestión del Agua en Arizona/Sonora: El ejemplo del Río San Pedro” (“Exploring Decision Support Models for Water Management in Arizona-Sonora: The Example of the San Pedro River”). Attendees included José Maria Martínez (Universidad de Sonora), José Luís Moreno (Colegio de Sonora), Nicolás Pineda (Colegio de Sonora), Manuel de Jesús Sortillón (Universidad de Sonora), Pablo Wong (Centro de Investigación en Alimentación y Desarrollo).
- November 2005. Cochise College DSS teaching demonstration for Technical Advisory committee of Upper San Pedro Partnership.
- January 2006. Colegio de Sonora teaching demonstration and lab for use of DSS model with climate components, seminar, “Especialidad en Gestión Integrada de Cuencas Hidrográficas” (“Specialization in Integrated Management of Hydrological Basins”).

### **c. Curriculum development**

When the research team leadership met in September 2004 to consider ways to adapt to the changed political circumstances in Mexico, all agreed that we needed to strongly continue to try to bridge the communications gap. One of the best ways to achieve this, we felt, was to concentrate on environmental education for the population at large. Such an approach would take advantage of vigorous efforts already underway in this area and to modify these by introducing curricular materials on climate variability and change. Another way to achieve an effective educational outreach was to participate with a demonstration and use of a Decision-Support System model at the Colegio de Sonora and the University of Sonora (as described in the preceding section).

#### **i. ECOSTART**

Research team: Anne Browning-Aiken, Denisse Fisher de León, Floyd Gray (UA Dept of Geosciences) and Yajaira Gray (Arizona-Sonora Desert Museum)

At the Udall Center, co-PI Anne Browning-Aiken has developed a program called ECOSTART, which is now in its third phase (ECOSTART III). With seed funding from EPA, SAHRA, the Morris K. Udall Foundation, and the International Rotary Club, she and her team have been working with primary and secondary school teachers in Arizona and Sonora to introduce environmental topics into existing school curricula. Until recently, most of the subject matter pertained to water resources, especially to issues involving the San Pedro. Now, under the impetus of the present project, with the assistance and cooperation of CLIMAS manager and co-PI Gregg Garfin, and in collaboration with co-PI Margaret Wilder, ECOSTART has been introducing new items on climate, drought, flooding, and forecasting. The aim is to raise awareness among young persons, who will eventually be stakeholders.

#### Activities

- November 2005. Organized and convened a two-day ECOSTART workshops with elementary, middle, and high-school teachers from Cochise County, AZ. The workshop addressed water quality, use, and management; ecosystem/watershed conservation; superficial and groundwater models; GPS functions; plant-animal interactions; and climate variability and change. The workshop received support from the Morris K. Udall Foundation, Project WET, the Arizona-Sonora Desert Museum, the GLOBE Program, and the Department of Geosciences at the University of Arizona. The workshops also included fieldtrips to both the San Pedro Riparian National Conservation Area and Wastewater Treatment and Recharge/Wetlands Facility.

- January 2006. Held two-day ECOSTART workshop, including test of climate units. Bisbee and Sierra Vista, Arizona.

\$ March 2006. Ecostart planning meeting with Cananea Rotary Club and school teachers.

\$ ———. ECOSTART workshop in Cananea, Sonora, with local teachers under auspices of International Rotary Club.

\$ June–November 2006. ECOSTART climate and water workshops with Pima County Vocational School teachers and students, Tucson, AZ.

**ii. CD: Bilingual Lesson Plans for the Binational Santa Cruz Watershed/Planes de Estudio Bilingües para la Cuenca Binational del Río Santa Cruz**

Research Team: M. Wilder, A. Browning-Aiken, Lisa Shipek, Gigi Owen, Denisse Fisher de León

As part of the project's curriculum-development activity, the research team prepared and has been distributing a CD containing a 4<sup>th</sup> grade unit "Drought Beyond Borders" and an 8<sup>th</sup> grade unit "Climate Change Beyond Borders," both in Spanish and English. The curriculum also is available on the Udall Center's Web site at: <http://www.udallcenter.arizona.edu/publications/santacruzwatershed/index.html>. Separate materials also have been prepared bilingually for the transboundary San Pedro River basin.

These materials have been peer-reviewed and field-tested in the Santa Cruz basin and are currently being peer-reviewed by members of the College of Education, the Extension Division, CLIMAS, and the GLOBE Education Program at the University of Arizona. Educators will review and field test the CD with the San Pedro adaptations in Cochise County. Revisions in response to the reviews will require a new modest source of funding.

Activities (August 2005-March 2006)

- Modify lesson plans based upon Tucson and Magdalena teachers' input and recommendations for making them more useful and better adapted for classroom needs.

\$ Translate into Spanish.

\$ Relating to Sonora, meet with other faculty on campus (e.g., Diane Austin, Anne Browning-Aiken) who have established relationships with other Sonoran teachers and in Sonoran environmental education programs, to begin disseminating it further.

\$ Meet with staff of Udall Center, CLIMAS Project, and Center for Latin American Studies Web site to upload and feature the 4<sup>th</sup> and 6<sup>th</sup> Grade Climate and Drought Curriculum on their Web sites in Spanish and English

\$ Distribute CDs and publicize site to educators in the region.

**d. Research on use of climate and water information in Mexico's northern border region**

Research team: Nicolás Pineda Pablos, Margaret Wilder, Anne Browning-Aiken

Goals

Interview Sonora municipal, state, and federal water agency officials concerning changes in the Mexican water laws and challenges to implementing water policy in the Mexican portion of the San Pedro basin—including challenges related to paucity of and extent of use of climate information. The research team also reviewed documents about the water service in Cananea, mainly in government and legal documents. This included inquiries at the Registro Público de Derechos de Agua, a review of the CNA annual report on water utilities and the benchmarks published by the Comisión Estatal de Agua Potable y Alcantarillado de Sonora.

### Activities

- Since February 2005. Interviews with Ing. Sergio Pablos and Ing. Francisco Salinas of COAPAES, regarding their system of benchmarking for water utilities in Sonora and the process of decentralization and transfer of water from the state administration into the municipalities.
- Since March 2005. Interviews with Dr. Roberto Salmón Castelo, Gerente Regional de la Comisión Nacional del Agua, regarding the situation of the Río San Pedro and other water topics in Sonora, and with José María Martínez regarding the situation of the Consejos de Cuenca and the organization of the well-water users in the Costa de Hermosillo.
- Since April 2005. Interviews with Ing. Renato Ulloa, Director de la Comisión de Agua Potable y Alcantarillado del Estado de Sonora (Coapaes), regarding the process of modernization and decentralization of water utilities, and with José Luis Corrales, director del Organismo Operador Municipal de Agua Potable y Alcantarillado (Oomapa) de Naco, Sonora. Additionally, interviews in Cananea with:
  - Sr. Jesús Ahumada (Chuchi) director del Patronato de Agua Potable (PAC) de Cananea
  - Ing. Rafael Valdez, director comercial del PAC
  - Ing. José Fernando Rodríguez, Director de Capacitación de la Empresa Minera de Cananea.
  - Francisco García Gamez, Presidente Municipal
  - Ing. Tirado Verdugo, Director de Obras Públicas del Municipio de Cananea.
  - Sr. José Rosario Trique, residente de Cananea y trabajador de la mina.
  - Sra. Isabel Rojas y Mercedes Salazar, bibliotecarias y ciudadanas de Cananea.
- Continuing work on research papers 2c and 2d (pages 9-10, above).

### **B. Preliminary findings**

At the time of this report, the project is 33 months into its original 36-month lifespan. Simultaneously with this submission and contingent on its approval we are requesting a 12-month no-cost extension in the life of the project.

In the first interim annual report, we reviewed some of the findings of the Mexican San Pedro Water and Climate Survey. We found appreciable vulnerability associated with lack of water infrastructure, water-quality concerns, and institutional issues—but other than susceptibility to drought and flood, little evidence for vulnerability to climate variability or change. It was clear, however, that the socioeconomic weaknesses tend to exacerbate existing vulnerability to climatic events. In addition, the survey revealed a number of insights into the most immediate concerns of and coping strategies employed by water users, managers, and decisionmakers. The observations below provide insight into the multiplicity of challenges faced by Mexican stakeholders in the Upper San Pedro River basin, and into how climate information might be successfully integrated into decision making at scales ranging from households to the entire upper basin.

As we have noted throughout this and previous reports, the project team has expended considerable effort solidifying relationships with stakeholders and academics in the region. We have believed from the start that trust can only be established via repeated personal contacts. In keeping with this notion, through numerous trips to the basin, a major effort has been expended on scientific collaboration through participation in regular project meetings and planning activities. During the 2004-05 project year, much of this effort was directed toward identifying the best strategies for achieving open communications with

and trust of key Mexican constituencies. Both of these factors were found essential to moving forward with regard to the central aim of the project, which is to improve the availability of useful, usable, and relevant climate information for people living on both sides of the border in the Upper San Pedro River basin.

During the past 11 months, the research team has expanded its reach and made a special effort to enlist the participation of broader networks of informants, stakeholders, and partners. In particular, we have forged strong relations with other institutions working on related projects—both in the U.S. and in Mexico. As identified on pages 5 and 6, this project is now working hand-in-hand with colleagues at NOAA/Boulder, NCAR, UNISON, ITSON, IMTA, and SMN. Within Mexico in particular, we have realized the importance of engaging and teaming up with officials and scholars working not only in the border region in Sonora, but others nearer to the capital city. Our attempts to implement a joint diagnostic climate outlook product and a DSS planning tool for the region have led to invaluable connections that we will continue to rely on in the coming year and beyond.

Much more than a year ago, we can assert that the contacts we have nurtured have paid off by facilitating access to people, institutions, and information. We have continued to strengthen our collaborations with counterpart scientists and to discuss ways to develop and implement better climate diagnostic products such as the prototype “Outlook” instrument described on pages 8 to 12. Other preliminary findings drawn from this project and closely related undertakings are shown in the expanding lists of publications and presentations that appear below. Still more research and writing is underway and by the project’s end, we will have amassed a sizable collection of peer-reviewed papers and other research products, as well as concrete achievements in the information-bridging realm.

Still other preliminary findings are:

- Such climate-related information as exists for Mexico is almost exclusively short-term weather information, e.g., Weather Channel, NOAA/NASA, Federal Electric Commission, and other Web sites. Local Protección Civil’s responsibility is to deal with potential crises due to weather. This is the niche the climate-outlook instrument seeks to fill.
- In Arizona and even more so in Mexico, all water information remains highly political, especially among agricultural districts or facilities maintained by the government.
- With a presidential election to take place in July 2006, Mexico’s future policies and actions in the water/climate domain are certain to be determined by the outcome, which is now uncertain.
- Until recently, there has been little if any interest in long-term climate programs, although the current sustained drought has palpably enhanced interest among officials, stakeholders, and citizens. As our meetings with Mexican colleagues have firmly shown, in spite of the tensions brought about by the caustic immigration debate, the political climate is now much more amenable to cross-border collaboration on water-and-climate issues than at any time in the past decade.
- The 2005 Water Management and Conservation Plan of the Upper San Pedro Partnership recognizes that each town in the Arizona portion of the upper basin needs to include an account of their drought management efforts for their comprehensive general plan. With sustained drought now posing serious problems in Mexico, cross-border linkages appear much more mutually desirable.
- The curriculum-development team led by co-PIs Margaret Wilder and Anne Browning-Aiken has developed two bilingual educational curriculum units on climate variability and change for primary and secondary schools for use in the Mexico-U.S. border communities. The results of this effort have now been made available to educators in the region and we are receiving requests for guidance with curricula and other advice.
- With new funding from the Sierra Club, ECOSTART II has begun integrating climate components into curricula for teachers in the San Pedro region.

- The impetus for a border-region climate-outlook product has been very substantially solidified through a series of high-level meetings and scientific exchanges.
- The Guaymas conference created a working group for funding strategies and at the meeting itself, more than a dozen such possibilities were discussed in detail. Participants from both countries have arranged to continue discussions with the aim of preparing and submitting joint proposals.
- The DSS initiative described on pages 13 and 14 is now receiving strong attention and appears ready for adoption by academic at UNISON, for eventual use in regional water-and-climate decisionmaking.
- In regard to the theme of this project, science and policy in the water-climate realm, relations among scientists and officials from the two countries have improved dramatically over the past year and never been stronger.

**C. Papers and presentations** (Note: Listings for publications and presentations are cumulative, with the current year's entries highlighted in bold.)

### Papers

- Browning-Aiken, A., A. Davis, F. Delgado, R. Carter, R. G. Varady, and B. Morehouse. Under review. Climate, water management, and policy in the San Pedro basin: results of a survey of Mexican stakeholders near the U.S.-Mexico border. Special issue of *Climatic Change*, ed. by P. Kabat.
- **Browning-Aiken, A., R. G. Varady, D. Goodrich, H. Richter, T. Sprouse, and W. J. Shuttleworth. 2006.** Integrating science and policy for water management: a case study of the Upper San Pedro River Basin. In *Hydrology and Water Law — Bridging the Gap: A Case Study of HELP Basins*, ed. by J. S. Wallace and P. Wouters. pp. 24-59. In *Water Law and Policy Series*, eds. P. Wouters and S. Vinogradov. IWA Publishing.
- Browning-Aiken, A. 2004. Funds of knowledge and border crossings. In *Theorizing Practices: Tapping the Funds of Knowledge in Households*, eds. N. Gonzales, L. Moll, and C. Amani. Charlottesville, VA: Hampton Press.
- Browning-Aiken, A., H. Richter, D. Goodrich, B. Strain, and R. G. Varady. 2004. Upper San Pedro Basin: fostering collaborative binational watershed management. Special issue of *International Journal of Water Resources Development* 20(3), 353-367. ed. by L. Andersson and D. W. Moody.
- Browning-Aiken, A., R. G. Varady, and D. Moreno. 2004. Water-resources management in the San Pedro Basin: Building binational alliances. *Journal of the Southwest* 45, 4: 611-627.
- **Dellinger, E., R. G. Varady, and A. Browning-Aiken. 2006.** *Water Policy Research on the San Pedro River Basin: An Annotated Bibliography of Contributions by the Udall Center for Studies in Public Policy, 1997-2006*. 13 pp.
- **Garfin, G., R. G. Varady, A. Ray, M. Cortez Vázquez, C. Watts, M. Montero Martínez, J. Garatuza Payán, C. Arias, W. Alatríste Candían, D. Gochis, A. López Ibarra, B. Morehouse, H. Diaz. 2006.** A bi-national climate information product for the U.S.-Mexico borderlands. Poster, "U.S.-Mexico Workshop on Monsoon Region Climate Applications." Sponsored by the NOAA Earth System Research Laboratory. Guaymas, Mexico. 8-12 May 2006.
- **Goodrich, D. C., E. Z. Stakhiv, A. Browning-Aiken, K. Vache, J. R. Ortiz-Zayas, J. F. Blanco, F. N. Scatena, R. G. Varady, W. B. Bowden, W. Howland. 2005.** The HELP (Hydrology for Environment, Life and Policy) experience in North America. *Prdgs. of the EWRI (ASCE Environmental & Water Resources Institute) Watershed Mgt. Conference*. Williamsburg, VA.
- Liverman, D., R. G. Varady, O. Chávez, R. Sánchez, A. Browning-Aiken, and L. Stauber. 2004. Asuntos ambientales en la frontera México-Estados Unidos: Temas y acciones. In *Fronteras en América del Norte: Estudios multidisciplinarios*, ed. by A. Mercado Celis and E. Gutiérrez Romero. Mexico City: Universidad Nacional Autónoma de México, Centro de Investigaciones Sobre América del Norte. pp.

279-293.

- **Pineda Pablos, N., A. Browning-Aiken, and M. Wilder. Submitted in June 2006.** Frontera Norte (journal of El Colegio de la Frontera Norte).
- **Ray, A., G. Garfin, M. Wilder, M. Lenart, and A. Comrie. In revision for resubmission, June 2006.** Applications of monsoon research: Opportunities to inform decisionmaking and reduce regional vulnerability,” *Journal of Climate Research*.
- Richter, H., D. C. Goodrich, A. Browning-Aiken, R. G. Varady. In press. Riparian Area Conservation in a Semi-Arid Region: The San Pedro Example. Chapter 9 in *Integrating Science and Policy for Water Management*. Ed. By J. C. Stromberg and B. J. Tellman. Tucson: University of Arizona Press.
- **Serrat-Capdevila, A., J. B. Valdes, J. Gonzalez, K. Baird, and A. Browning-Aiken. 2006.** Climate change impacts in Arizona/Sonora: The San Pedro Basin study case. Poster, “U.S.-Mexico Workshop on Monsoon Region Climate Applications.” Sponsored by the NOAA Earth System Research Laboratory. Guaymas, Mexico. 8-12 May 2006.
- **Varady, R. G., M. C. Lemos, M. Wilder, E. Dellinger McGovern, and G. Owen. In progress.** Understanding stakeholder processes in the Colorado River Delta region: Policy networks, conservation and institutional change” to be submitted to a water resources journal.
- **Varady, R. G., M. Wilder, S. Eden, A. Browning-Aiken, K. Jacobs, and J. Valdes. 2006.** ‘Mega-networking’ at the Fourth World Water Forum in Mexico City: looking for opportunities at a megaconference. “Guest View” in *Arizona Water Resource* 14, 5.
- **Varady, R. G., and A. Browning-Aiken. 2005.** The birth of a Mexican watershed council in the San Pedro basin in Sonora.. In *Planeación y Cooperación Transfronteriza en la Frontera México-Estados Unidos* (Transboundary Planning and Cooperation in the U.S.-Mexico Border Region), ed. by C. Fuentes and S. Peña. pp. 165-183.
- Varady and Browning-Aiken. 2004-05. Contribution to Good Neighbor Environmental Board annual report, *Water Resources Management on the U.S.-Mexico Border*. Recognition of the impacts of climate variability and human vulnerability along the U.S.-Mexico border under section “Data, Drought and Floods.”
- Varady, R. G., and B. J. Morehouse. 2004. *Cuanto cuesta?* Development and water in Ambos Nogales and the Upper San Pedro Basin. In *The Social Costs of Industrial Growth in Northern Mexico*, ed. by K. Kopinak. La Jolla, CA: Center for U.S.-Mexican Studies, UCSD. pp. 205-248.
- **Wilder, M., and P. Romero Lankao. Forthcoming 2007.** Paradoxes of decentralization: Neoliberal reforms and water institutions in Mexico.” *World Development*.
- **Wilder, M. forthcoming 2006.** Equity and water in Mexico’s changing institutional landscape. In R. Perry, H. Ingram, and J. Whiteley, eds., *Water and Equity: Apportioning Water Among Places and Values*. Massachusetts Institute of Technology (MIT) Press Series on American and Comparative Environmental Politics and Policy.
- **Wilder, M., and S. Whiteford. 2006.** Flowing uphill toward money: Groundwater management and ejidal producers in Mexico’s free trade environment,” in Laura Randall, ed., *Changing Structure of Mexico: Political, Social and Economic Prospects*. New York: M.E. Sharpe.
- **Wilder, M. 2005.** Water, power and social transformation in Mexico: Neoliberal Reforms in Mexico. *Vertigo: La Revue de l’Environnement* 6, 2 (September 2005). Montreal: Université de Québec de Montreal.

## Presentations

- **Browning-Aiken, A. 2005.** Managing water resources in semi-arid ecosystems along the U.S.-Mexico border: regional responses to climate changes in an Arizona-Sonora transboundary basin. "Global Change in Arid Lands," Association of Pacific Coast Geographers conference. Phoenix, Arizona. October.
- **Browning-Aiken, A. 2006.** Challenges to implementing transboundary water planning: A political ecology perspective on recent policy changes, management regimes, and institutional practices in U.S. and Mexico. Presented at Fourth World Water Forum as Local Action with IWRM cross-cutting theme. Mexico City, Mexico. 18 March.
- **Browning-Aiken, A. 2006.** Participated in panel "Space-based Water Observations: Alliances for Providing Information Essential for Managing the World's Water Resources." Fourth World Water Forum as Local Action with IWRM cross-cutting theme. Mexico City, Mexico. 20 March.
- **Browning-Aiken, A. 2006.** Managing water resources in semi-arid ecosystems along the U.S.-Mexico border: regional responses to climate changes in an Arizona-Sonora transboundary basin. Presented in panel "Current Challenges on the Binational Water Agenda: Regional Responses along the U.S.-Mexico Border," at Association of Borderlands Studies Conference. Phoenix, AZ. 21 April.
- **Browning-Aiken, A. and A. Serrat Capdevila. 2006.** Binational academic collaboration in water management support models: An approach and a tool towards collaborative management in the border area. Presented at Association of Borderlands Studies Conference. Phoenix, AZ. 21 April.
- Browning-Aiken, A., and N. Pineda. 2005. Challenges to implementing Mexican water policy: a political ecology perspective on water resource collaboration, institutional bureaucracy, and local participation" presented at the Society for Applied Anthropology Conference, Santa Fe, NM. April.
- Browning-Aiken, A. 2005. Presentation on San Pedro basin at Workshop on Options for Use of Climate Vulnerability Index (CVI), sponsored by UNESCO International Hydrologic Programme (IHP)/HELP, Guayaquil, Ecuador, 21-23 March. Organized by Robert Varady.
- Browning-Aiken, A. 2005. "Climate variability and ecosystem impacts in the Southwest: proactive planning for natural resource conflicts," Impacts in Southwestern Forests and Woodlands, Sedona, AZ, 7-9 Feb.
- Browning-Aiken, A. 2004. HELP presentation on the San Pedro (U.S.-Mexico) and Lake Peipsi (Estonia/Russia) demonstrated how in different climatic, ecologic, and national regions, similar issues were raised, such as the importance of establishing trust, sharing information, and the difficulties posed by economic and political asymmetries, Second International Symposium on Transboundary Water Management, Tucson, AZ, 16-19 Nov.
- Browning-Aiken, A. 2004. Invited panelist and presenter on social issues regarding water and climate in the U.S.-Mexico San Pedro basin. Seminário Internacional Sobre Gestvo Social De Bacias Hidrográficas (International Seminar on Social Management of Watersheds), Urubici E Florianópolis, Santa Catarina, Brazil. 6-14 Aug.
- Browning-Aiken, A., R. G. Varady, B. Morehouse, and A. Davis. 2004. Pioneering a binational dialogue on water and climate: implementing institutional change. Presented at the AWR & IWLRI International Specialty Conference on Good Water Governance for People and Nature, "What Roles for Law, Institutions, Science and Finance?" Dundee, Scotland. 30 Aug.
- Garfin, G., 2004. Borderlands Drought. Presentation (invited) to the Good Neighbor Environmental Board Meeting, Douglas, AZ. 17 Oct.
- Goodrich, D. C., E. Z. Stakhiv, A. Browning-Aiken, K. Vache, J. R. Ortiz-Zayas, J. F. Blanco, F. N. Scatena, R. G. Varady, W. B. Bowden, W. Howland. 2005. The HELP (Hydrology for Environment, Life and Policy) experience in North America. Presented at EWRI (ASCE Environmental and Water Resources Institute) Watershed Management Conference. Williamsburg, VA. 20 July.
- Rojas-Salazar, C., A. Serrat Capdevila. 2005. "Watershed Management in the Context of Climate Change: The Upper San Pedro Basin" (poster) presented at the Encuentro. 16-17 May.

- **Serrat-Capdevila, A., J. B. Valdes, J. Gonzalez, K. Baird, and A. Browning-Aiken. 2006.** Climate change impacts in Arizona/Sonora: The San Pedro Basin study case. Presented at the Third International Symposium on Transboundary Waters Management. Ciudad Real, Spain. 30 May-2 June.
- **Varady, R. G., and A. Browning-Aiken. 2006.** Building crossborder alliances in environmental-resources policy and management: Udall Center experiences. Presented at 6th Conference on Research and Resource Management in the Southwest Deserts: Borders, Boundaries and Time Scales. Tucson, AZ. 4 May.
- Varady, R. G., and B. Morehouse. 2004. *Cuanto Cuesta?* Environmental costs of development in the U.S.-Mexico border region. Presented at the XXV International Congress of LASA (Latin American Studies Association). Las Vegas, NV. 9 Oct.
- **Wilder, M. 2006.** Climate change in regional context,” (presented in Spanish). Keynote presentation at U.S.-Mexico Workshop on Monsoon Region Climate Applications. Sponsored by the NOAA Earth System Research Laboratory. Guaymas, Mexico. 8 May.
- **Wilder, M. 2006.** “Human Dimensions of Sustainability,” presented at “Borders, Boundaries and Time Scales: Sixth Conference on Research and Resources in the Southwestern Deserts.” Sheraton Tucson Hotel, Tucson, Arizona. 2 May.
- **Wilder, M. 2006.** “Water and the State: Transforming the Governance Paradigm in Mexico,” Latin American Studies Association meeting. San Juan Puerto Rico. 17 March.
- Wilder, M. 2005. “Water, Governance and the State: Narratives and Denouements of Decentralization in Mexico,” Association of American Geographers Annual Meeting. 9 April.
- Wilder, M. 2005. Contributed to Andrea Ray’s presentation at North American Monsoon Experiment (NAME) meeting, Mexico City. 10 Mar.
- Wilder, M. 2004. Invited plenary speaker, “Water, Power and Social Transformation in Mexico’s Water Sector,” “Water in the Americas” conference, Quebec, Canada. 10 Oct.
- Wilder, M. 2005. Invited plenary panel speaker, Urban Affairs Association Annual Meeting, Salt Lake City, Utah. 15 April.

#### IV. Relevance to the Field of Human-environment Interactions

The project is premised on the inseparability of the sociopolitical setting of the use of climate science from the application of that science. Because the two theaters in which this project is taking place—the U.S. and Mexican portions of the same river basin—are so radically different in nearly every way, they afford a fine opportunity to observe the critical human influences on what many scientists and managers once assumed were purely technical, and thus manifestly tractable problems.

The project’s findings about resistance to the use of climate diagnostic products, for different reasons in the two countries, strongly confirm the importance of context. In Mexico, especially, we have witnessed first-hand the difficulties of navigating a well-established and change-averse decisionmaking system. The project is a firm reminder that understanding and analyzing the use of climate information varies in each society and to a large degree, in each local setting.

But at the same time, we have learned during the past year that political barriers such as the ones cited above can be overcome through cautious building of relationships, especially ones based on sharing scientific processes and outcomes. By means of deliberately expanding our network, we have been able to overcome some of the difficulties posed by dealing with officials of another country. In short, we have found that cross-border partners in science and research are the best means of communicating with and alleviating the concerns of agency officials.

We have affirmed that information, tools, and instruments are not adopted merely on the strength of their utility or elegance. Instead, successful introduction of such products requires close familiarity with local, national, and transnational issues; institutions; and actors—and in many cases membership or acceptance in the target society. Though inefficient, the only ways to overcome social, cultural, political, and in some cases legal barriers is through dedicated, time-consumptive, relationship-building efforts. While during the first two years, we found these efforts to be occasionally frustrating, the past year has led to openings and breakthroughs to be exploited over the coming months.